

<p align="center">LLNL Environmental Restoration Division Standard Operating Procedure</p>	<p align="center">TITLE: Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water and Soils</p>
<p>APPROVAL _____ Date _____</p> <p>Environmental Chemistry and Biology Group Leader</p>	<p align="center">PREPARERS: V. Dibley, S. Gregory, and G. Howard</p> <p align="center">REVIEWERS: R. Brown*, T. Carlsen, E. Christofferson*, J. Duarte, B. Failor*, J. Gardner**, C. Garcia*, J. Greci, J. Hoffman**, B. Hoppes*, S. Kawaguchi, S. Mathews*, G. Kumamoto, and B. Ward*</p>
<p>APPROVAL _____ Date _____</p> <p>Division Leader</p> <p>CONCURRENCE _____ Date _____</p> <p>QA Implementation Coordinator</p>	<p align="center">PROCEDURE NUMBER: ERD SOP-4.8</p> <p align="center">REVISION: 2</p> <p align="center">EFFECTIVE DATE: December 1, 1995</p> <p align="center">Page 1 of 9</p>

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1.0 PURPOSE

To ensure accurate and consistent field chemistry, water level, and organic vapor measurements using measuring and test equipment (M&TE) such as 1) pH meter, 2) conductivity meter, 3) dissolved oxygen meter and probe, 4) radiation survey meter, 5) water-level indicator, 6) organic vapor meter, and 7) explosimeter.

2.0 APPLICABILITY

This procedure is applicable to all M&TE used by ERD for the collection of field data.

3.0 REFERENCES

3.1 Beckman Instruments, *Omega 2 pH Meter Owner/Operator Manual*.

3.2 Hydrolab, *H₂O G Multiprobe Owner/Operator Manual*.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 2 of 9
------------------------------	----------------------	------------------------------------	-------------

3.3 Ross, W. (1986), *HS-660 Radiation Survey Instruments*, Instruction material.

3.4 Shingleton, K. (1986), *HS-601 Radiation Safety Orientation*, Instruction material.

3.5 Yellow Springs Instruments (YSI), *3500 Meter Owner/Operator Manual*.

3.6 Environmental Protection Department (EPD) Quality Assurance Management Plan (QAMP).

3.7 Foxboro, *Portable Organic Vapor Analyzer Owner/Operator Manual*.

3.8 Thermal Environmental Instruments (TEI), *Portable Organic Vapor Meter Owner/Operator Manual*.

4.0 DEFINITIONS

4.2 Calibration

The comparison of a measurement, standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies, and to report or eliminate those inaccuracies by adjustments.

4.1 Measuring and Test Equipment (M&TE)

Devices or systems used to calibrate, measure, gauge, test, or inspect in order to control or acquire data to verify conformance to specified requirements.

4.2 Verification

The act of evaluating and documenting whether processes, items, services, or documents meet specified requirements.

5.0 RESPONSIBILITIES

5.1 Division Leader

The Division Leader's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely and comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Field Personnel

Field personnel are responsible for the calibration verification and maintenance of the M&TE according to documented maintenance and calibration schedules. A calibration verification shall be performed by the field personnel whenever the accuracy of the M&TE is suspect, regardless of the regular schedule. All calibration verification and maintenance activities are recorded in the instrument logbook and field data sheet, when applicable.

5.3 Sampling Coordinator (SC)/Drilling Coordinator (DC)

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 3 of 9
------------------------------	----------------------	------------------------------------	-------------

The SC/DC is responsible for approving the selection of field instruments with agreement from the QC Chemist or the Environmental Chemistry and Biology Group Leader (ECBGL). The SC/DC is responsible for the training of field personnel on the proper use of M&TE and for ensuring that field teams implement and document these procedures in each instrument logbook. The SC/DC is also responsible for peer reviewing the measurement data collected by field personnel.

5.4 QC Chemist

The QC Chemist is responsible for maintaining traceability documentation of calibration standards used for field instrumentation and providing guidance to field personnel on the proper storage and handling methods for calibration standards. The QC Chemists are also responsible for periodic assessments of M&TE calibration procedures.

6.0 PROCEDURE

6.1 Documentation Requirements

- 6.1.1 The following information should be documented in the field sampling, drilling, or treatment facility logbook:
 - A. Date of entry and initials of the individual recording the entry.
 - B. Results of the calibration verification.
 - C. Information on the standards and method used for calibration verification, including standard preparation details.
 - D. Next calibration date, when appropriate.
 - E. Maintenance performed.
 - F. Operator comments.
- 6.1.2 The calibration verification status of all M&TE shall be indicated in the field sampling, drilling, or treatment facility logbook. When appropriate, calibration status shall also be indicated by placing a label on the instrument. The label should contain the calibrator's initials, calibration date, and next calibration due date.
- 6.1.3 Standards used for M&TE calibration and calibration verification shall be traceable to the National Institute of Standards and Technology (NIST) or other recognized national standards whenever possible. If NIST standards do not exist, the reference standards used should be supported by certificates, reports, or data sheets. All traceability documentation should be forwarded to the QC Chemist with copies or other appropriate information attached in the field sampling, drilling, or treatment facility logbook. If the standards do not come with storage and handling guidance to maintain the required accuracy and characteristics of the standard, the ECBGL or QC Chemist should be consulted.
- 6.1.4 All maintenance activities should be recorded in the field sampling, drilling, or treatment facility logbook. Document the date when each instrument (M&TE) and any associated probes are put into service, repaired, and taken out of service in the logbook.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 4 of 9
------------------------------	----------------------	------------------------------------	-------------

6.2 Choosing Field Instruments (M&TE)

Many field models of the instruments listed in section 1.0 exist on the market. In order to avoid limiting the field personnel to one particular model or make of an instrument, only general calibration and calibration verification instructions are presented here. Also, only the commonly used types of instruments will be discussed. Instruments which are used only occasionally, and especially those owned by outside contractors, are to be calibrated, verified, and maintained as per the instrument manual. The operator should always use the owner/operator manual as the primary source of information on calibration and calibration verification procedures.

6.2.1 General selection criteria for choosing field instruments are given below:

- A. Instruments should be made by a well-known, reputable company. Qualified individuals (chemists, geochemists, experienced field personnel) who have used the instrument in the past should be consulted.
- B. Do not use instruments that are fragile or sensitive to water, heat, or cold. Field instruments should be rugged and constructed specifically for field work.
- C. The range of the instrument should bracket the expected sample concentrations.
- D. New instruments should be tested for precision and accuracy prior to use. This is done by calibrating the instrument, then making multiple measurements with samples that vary over the range of the instrument's sensitivity. The SC/DC in conjunction with the ECBGL or QC Chemist will determine if the instrument has acceptable accuracy and precision. The precision/accuracy analysis should be documented in the appropriate logbook.

6.3 Calibration Nonconformances

- 6.3.1 Any M&TE found damaged or malfunctioning should be removed from service immediately, the condition shall be documented in the instrument logbook and the appropriate steps should be taken to restore the M&TE or a back-up unit should be used.
- 6.3.2 If any M&TE is found to be out of calibration during the collection of measurement data, the condition shall be documented on a Quality Improvement form (QIF). The deficiency shall be evaluated and corrective action shall be taken. The prospective users and recipients of the associated measurement data shall be notified of the results of the QIF. Acceptance of measurements made with uncalibrated M&TE needs to be reviewed by the QAIC and justification for acceptance documented. Instructions for filing a QIF can be found in Section 6.8.5 of SOP 4.6, "QA/QC Objectives for Nonradiological Data Generated by Analytical Laboratories."

6.4 Office Preparation

- 6.4.1 Coordinate schedules/actions with the SC/DC.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 5 of 9
------------------------------	----------------------	------------------------------------	-------------

- 6.4.2 Choose instruments to be used that have been approved by the SC/DC, ECBGL or QC Chemist.
- 6.4.3 Store the owner/operator manual(s) with the M&TE so it is available for review.
- 6.4.4 Locate all necessary field supplies (deionized water, tissues, etc. such as Kim-Wipes or Kaydrys to clean instrument) and ensure a sufficient supply of all necessary buffers and standard solutions. It is the responsibility of the personnel performing the monitoring or sampling activities to obtain necessary supplies. Contract sampling personnel are required to supply their own supplies such as buffer standard solutions.
- 6.4.5 Ensure each M&TE is in operational order and properly charged (good batteries, functional LCDs or analog displays, etc.).
- 6.4.6 Locate back-up M&TE in the case of failure.

6.5 Field Preparation

Locate a clean, protected area in which to set up and verify M&TE calibration.

6.6 Operation

6.6.1 pH Meter

At a given temperature the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Since pH is dependent upon temperature, all meters must have a temperature measurement and compensation mode. Otherwise, the calibration verification should be made at the same temperature ($\pm 2^{\circ}\text{C}$) as the samples. ERD must collect pH readings to verify that the system has reached equilibrium prior to the collection of samples.

- A. The pH meter calibration will be verified a minimum of once a day just prior to the day's first measurement using traceable, fresh buffer solutions of pH 4, 7, and/or 10. Buffer solutions should have expiration dates stamped on the container. Expired buffers are not to be used.
- B. The pH meter manufacturer's instructions will be followed when calibrating the instrument.
- C. The calibration can be accepted if the measured pH of the pH 7 buffer is within one tenth (i.e., $\text{pH} = 7.0 \pm 0.1$). If the measured pH falls outside that range, try one or all of the following:
 - 1. Double check the temperature of the buffer. Although small, temperature does affect the pH of the solution. The buffer is only at pH 7.0 when it is exactly 25.0°C . An extremely hot or cold solution could make the measurement fall outside the range of acceptability. Try heating or cooling buffers to closer to 25° and recalibrate.
 - 2. Replace all buffers.
 - 3. Replace probe filling solution.
 - 4. Look for indication that there is a problem with the meter or probe. Many meters have an indicator on the screen which displays when there is a potential problem.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 6 of 9
------------------------------	----------------------	------------------------------------	-------------

5. Consult the trouble shooting section of the equipment manual or locate a back-up unit.

- D. All calibration information shall be recorded in the field sampling, drilling, or treatment facility logbook and documented on the appropriate field sampling sheets.
- E. The pH meter shall be stored and handled according to manufacturers specifications to maintain accuracy.

6.6.2 Conductivity Meter

Conductivity is a numerical expression of the ability of an aqueous solution to transmit an electrical current. This ability depends on the presence of ions, therefore, high conductivity will be observed when the pH is very high or very low. Conductivity is also temperature dependent, so all meters must have a temperature compensation mode. Otherwise, the calibration verification should be made at the same temperature ($\pm 2^{\circ}\text{C}$) as the samples.

- A. Electric or specific conductivity meters, such as the Amber Science Model 605, Purge Saver Model FC2000, or a Yellow Springs Instruments (YSI) 3500 combination meter, are generally factory calibrated. The meter calibration is verified prior to each day's use with NIST traceable or equivalent potassium chloride salt (KCl) standard. Choose the conductance of the standard to be near the expected range of the samples (generally between 500 and 1500 $\mu\text{mhos/cm}$).
- B. If the calibration is out of range, then locate a back-up instrument.
- C. The manufacturers instructions shall be followed when calibrating the instrument.
- D. All calibration information shall be recorded in the field sampling, drilling, or treatment facility logbook and documented on the appropriate field sampling sheets and/or sampling/field logbook.
- E. The specific conductivity meter shall be stored and handled according to manufacturer's specifications to maintain accuracy.

6.6.3 YSI Dissolved Oxygen (DO) Meter

Depending the instrument to be used, either consult the YSI DO meter calibration section in Reference 3.5 or use the following calibration verification procedure before use daily:

- A. Fill DO sensing probe with new filling solution and seal it by positioning the semi-permeable membrane over opening and encircling the tip with the probe O-ring. There can be no air bubbles within the chamber and no wrinkles in the membrane where the O-ring seals off the membrane. This procedure only needs to be done if the membrane has been allowed to dry out or if a bubble has developed within the probe chamber. It is recommended that if the meter has not been used for a period of more then 30 days, that the membrane be changed.
- B. Make the zero and red-line adjustments to the meter using the zero and red-line adjustment knobs, and set the salinity adjustment knob to fresh water.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 7 of 9
------------------------------	----------------------	------------------------------------	-------------

- C. Fill half way a 1-liter closeable container with deionized (DI) water, and shake container vigorously for 15 minutes to saturate the water with oxygen (O₂). Open the container every 3 or 4 minutes during shaking to allow fresh air to enter.
- D. Open the container and measure the temperature of the DI water by turning the control knob to temperature. Reclose the container and continue to shake until ready to calibrate.
- E. Consult the saturation table on back of instrument to obtain the appropriate O₂ concentration (mg/L) at that temperature. Position the control knob to the Read O₂ position using the appropriate scale. Immediately insert the probe into the water and gently move the probe back and forth. Using the calibration adjust knob, set the instrument so that the needle aligns with the correct O₂ concentration.
- F. Repeat steps D and E above until no adjustment is necessary.
- G. All calibration information shall be recorded in the field sampling, drilling, or treatment facility logbook and documented on the appropriate field sampling sheets.
- H. The DO meter shall be stored and handled according to manufacturers specifications to maintain accuracy.

6.6.4 Radiation Survey Meters

- A. Radiation Survey Meters are calibrated and maintained by the Hazards Control Department of LLNL. Depending on the type of radiation encountered or expected (alpha, beta, gamma, or x), the appropriate meter is obtained from Hazards Control. For beta and gamma radiation detection, ion chambers (Eberline RO-2, Eberline PIC-6A and Victoreen 471) and Geiger counters (Eberline E-120) are available; proportional counters (LLNL "Blue" alpha meter) are available for alpha radiation detection.
- B. All personnel using radiation survey meters must take the Hazards Control classes HS-660, Radiation Survey Instruments, and HS-601 Radiation Safety Orientation.
- C. Each instrument obtained from Hazards Control has a label indicating the date of the last calibration, its next scheduled calibration, and the initials of the individual who performed the calibration. Record this information in the field logbook and on any field log sheets.

6.6.5 Water-Level Indicator

- A. Check the electric water level indicators against a steel surveyor's tape quarterly or following any incident which may cause the cable to stretch. If the electric water level sounder is found to be inaccurate by greater than 0.01 foot, discontinue use of the sounder and arrange for its repair.
- B. All documentation of the verification of the water level indicators accuracy shall be recorded in the field sampling logbook.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 8 of 9
------------------------------	----------------------	------------------------------------	-------------

6.6.6 Organic Vapor Meter or Analyzer (OVM or OVA)

The OVM/OVA is a broad category of instruments which can determine total volatile organic compound concentrations in vapor. They may have either a flame ionization detector (FID), or a photoionization detector (PID).

- A. The OVM/OVA (TEI Model 580A, PhotoVac Tip, HNU probe, Foxboro, or equivalent) is factory calibrated against either an isobutylene or benzene standard. Some of the instruments (such as the TEI) must be recalibrated by the factory semi-annually. A label shall be affixed to the OVM/OVA to indicate next calibration date. Other instruments (such as the PhotoVac) can be calibrated by purchasing a calibration kit from PhotoVac or calibration standards from other sources, and following manufacturer's instructions.
- B. The OVM/OVA calibration should be verified daily by the user with the appropriate standard.
- C. All calibration information shall be recorded in the instrument calibration and maintenance logbook, when appropriate and documented on the appropriate field sampling sheets and/or treatment facility, field sampling, or drilling logbook.
- D. The OVM/OVA shall be stored and handled according to manufacturers specifications to maintain accuracy.

6.6.7 Explosimeters

Explosimeters are used to monitor ambient conditions for oxygen content. Explosimeters are calibrated by the Hazards Control Department of LLNL for ERD. Each instrument obtained from Hazards Control has a label indicating the date of the last calibration, its next scheduled calibration, and the initials of the individual who performed the calibration. Record this information in the field logbook and on any field log sheets.

6.7 Maintenance

- 6.7.1 Inspect all M&TE prior to each day's use. Replace all irreparably damaged probes. Check electrolyte solution in pH and DO probes; fill as necessary. Check DO probe membrane for damage; replace as necessary. Replace or charge batteries as needed. Check operation of all instrument displays. If inoperable, arrange for repair and/or replacement.

6.8 Post Field Operation

- 6.8.1 Decontaminate M&TE per SOP 4.5, "General Equipment Decontamination."
- 6.8.2 Return M&TE to appropriate storage area.

6.9 Office Post Operation

- 6.9.1 Verify that all calibration, maintenance, or repairs are recorded in the appropriate field sampling, drilling, or treatment facility logbook, and on the appropriate field sheets.

Procedure No. ERD SOP-4.8	Revision Number 2	Effective Date December 1, 1995	Page 9 of 9
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- 6.9.2 Arrange for repair, replacement, or recalibration of any damaged or defective field M&TE.
- 6.9.3 Inform the SC/DC if supplies such as calibration standards or gases become low. Contract sampling personnel are responsible for the replacement of their supplies.

7.0 QA RECORDS

- 7.1 M&TE Calibration and Maintenance Logbooks
- 7.2 Field Sampling Logbooks
- 7.3 Field Sampling Sheets
- 7.4 Treatment Facility Logbooks
- 7.5 Completed QIFs
- 7.6 QIF Logbook

8.0 ATTACHMENTS

Not applicable.